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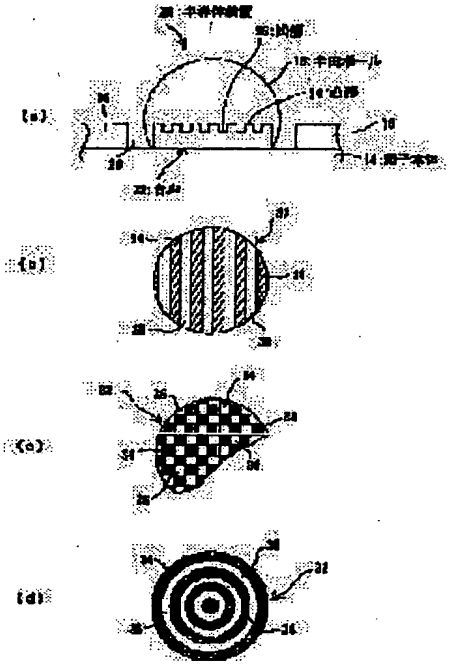
(54) SEMICONDUCTOR DEVICE AND ITS MANUFACTURE

(57)Abstract:
PROBLEM TO BE SOLVED: To relax shear stress acting on solder balls when a semiconductor device is mounted.

SOLUTION: A semiconductor device 30 is equipped with a pad 32 of copper on the outer terminal of a device main body 14, and a solder ball 18 is provided covering the pad 32. The pad 32 is possessed of projections 34 and recesses 36 on its upside. These projections 34 and recesses 36 are formed like belts, a checkered pattern or concentric circles, so that a joint surface between the pad 32 and the solder ball 18 is enhanced in area. The projections 34 are deflected and deformed by shear stress imposed on solder (solder ball 18) to relax the shear stress absorbing it partly when the solder ball 18 is melted and the semiconductor device 30 is mounted on a board.



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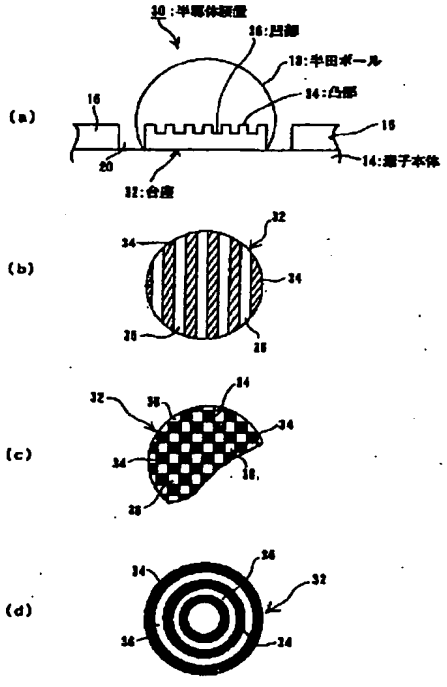
(54)【発明の名称】　半導体装置およびその製造方法

(57)【要約】

【課題】　実装の際に半田ボールに作用する剪断応力を緩和する。

【解決手段】　半導体素子３０は、素子本体１４の外部端子に銅からなる台座３２が形成してあって、半田ボール１８が台座を覆うように設けてある。台座３２は、上面に複数の凸部３４と凹部３６とを有する。これらの凸部３４と凹部３６とは、帯状、市松模様状または同心円状に形成してあり、半田ボール１８との結合面積を大きくしてある。凸部３４は、半田ボール１８を溶融して半導体素地３０を基板に実装した際に、半田（半田ボール１８）に作用する剪断応力によって撓んで変形し、剪断応力の一部を吸収して応力を緩和する。



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【特許請求の範囲】

【請求項１】　外部接続端子に半田ボールを固着した半導体装置において、前記半田ボールを固着する台座の表面に凸部または凹部を形成したことを特徴とする半導体装置。

【請求項２】　前記凸部または前記凹部は、複数設けてあることを特徴とする請求項１に記載の半導体装置。

【請求項３】　前記複数の凸部は、剣山状に形成してあることを特徴とする請求項２に記載の半導体装置。

【請求項４】　前記台座は、茸状に形成してあることを特徴とする請求項１に記載の半導体装置。

【請求項５】　外部端子を有する能動面に導電性金属層を形成する工程と、前記金属層の上に第１のレジスト膜を設けてパターニングし、前記外部端子に対応した部分以外の前記金属層を露出させる工程と、
前記金属層の露出部をエッチングして除去したのち、第１のレジスト膜を取り去る外部端子位置に前記金属層からなる台座を形成する工程と、
前記能動面の上部に第２のレジスト膜を設けてパターニングし、前記台座の上の一部にのみ前記第２のレジスト膜を残す工程と、
前記台座をハーフエッチングしたのち、第２のレジスト膜を除去して台座の上面に凸部または凹部を形成する工程と、
前記台座を覆って半田ボールを設ける工程と、
を有することを特徴とする半導体装置の製造方法。

【請求項６】　外部端子を有する能動面に導電性金属層を形成する工程と、
前記金属層の上に第１のレジスト膜を設けてパターニングし、前記外部端子と対応した部分の一部にのみ第１のレジスト膜を残す工程と、
前記金属層をハーフエッチングしたのち、前記第１のレジスト膜を除去する工程と、
前記能動面の上部に第２のレジスト膜を設けてパターニングし、前記外部端子に対応した部分以外の前記金属層を露出させる工程と、
前記金属層の露出部をエッチングして除去したのち、第２のレジスト膜を取り去って外部端子位置に凸部または凹部を有する台座を形成する工程と、
前記台座を覆って半田ボールを設ける工程と、
を有することを特徴とする半導体装置の製造方法。

【請求項７】　外部端子を有する能動面に導電性金属薄膜を形成する工程と、
前記金属薄膜の上に第１のレジスト膜を設けてパターニングし、前記外部端子に対応した部分の前記金属薄膜を露出させる工程と、
前記金属薄膜の露出部に導電性金属を堆積して金属堆積層を形成したのち、前記第１のレジスト膜を除去する工程と、
前記能動面の上部に第２のレジスト膜を形成してパターニングし、前記金属堆積層の一部にのみ前記第２のレジスト膜を残す工程と、
前記金属堆積層の露出部をハーフエッチングするとともに、前記金属薄膜の露出部をエッチングして除去したのち、前記第２のレジスト膜を取り去って外部端子位置に凸部または凹部を有する台座を形成する工程と、
前記台座を覆って半田ボールを設ける工程と、
を有することを特徴とする半導体装置の製造方法。

【請求項８】　外部端子を有する能動面に導電性金属薄膜を形成する工程と
、前記金属薄膜の上に第１のレジスト膜を設けてパターニングし、前記外部端子に対応した部分以外の前記金属薄膜を露出させる工程と、
前記金属薄膜の露出部をエッチングして除去したのち、前記第１のレジスト膜を取り除く工程と、
前記能動面の上部に第２のレジスト膜を設けてパターニングし、前記外部端子と対応した位置の前記金属薄膜を露出させる工程と、
露出させた前記金属薄膜の上に導電性金属を前記第２のレジスト膜の上部までメッキしたのち、第２のレジスト膜を除去して外部端子位置にメッキした前記導電性金属による台座を形成する工程と、
前記台座を覆って半田ボールを設ける工程と、
を有することを特徴とする半導体装置の製造方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、半導体装置に係り、特にボールグリッドアレイ（ＢＧＡ）のように外部接続端子に半田ボールを固着した半導体装置およびその製造方法に関する。

【０００２】

【従来の技術】近年、半導体装置の高集積化、小型化が強く要請されており、チップ程度の大きさのパッケージ、いわゆるチップサイズパッケージ（ＣＳＰ）の開発が行なわれている。このような小型のパッケージにおいては、多ピン（多端子）化を図るために、半導体素子やパッケージの能動面に外部接続端子をマトリックス状に配置し、外部接続端子に半田ボールを固着している。図７は、半田ボールを有する従来の半導体素子の一部を示したものである。

【０００３】図７おいて、半導体素子１０は、素子本体１４の表面の外部接続端子と対応した位置に台座１２が銅の薄層によって形成してある。また、素子本体１４の表面には、台座１２の周縁部を覆っているソルダレジスト１６が設けてある。そして、台座１２のソルダレジスト１６に覆われていない部分には、半田ボール１８が固着してある。

【０００４】ところで、ＣＳＰなどの半導体装置においては、高集積化、多ピン化を図るために台座１２や半田ボール１８の大きさが直径で２００～３００μｍ程度に

制約される。このため、台座１２と半田ボール１８との接合面積が小さくなり、両者の結合力が不足して半導体素子１０を基板に実装したときに、半導体チップ１０と実装基板との熱膨張率の相違から半田ボール１８に大きな剪断応力が作用し、半田ボール１８が台座１２から剥離する問題を生ずる。そこで、半田ボール１８と台座１２との結合力を高めるために、図８のような構造の端子が提案されている。

【０００５】すなわち、ソルダレジスト１６を台座１２に被せずに、台座１２とソルダレシズト１６との間に間隙２０を形成し、半田ボール１８の下部が台座１２の側面を覆うようにし、半田ボール１８と台座１２との接合面積を大きくするとともに、実装の際に半田ボール１８に作用する剪断応力を台座１２を介して素子本体１４によって受けるようにしている。

【０００６】

【発明が解決しようとする課題】ところが、上記した従来の半導体装置においては、半導体素子１０の基板への実装の際に、半田ボール１８に作用する剪断応力を台座１２を介して素子本体１４に伝達するようになっていて、半田ボール１８に作用する剪断応力を緩和する構造を有していないため、また台座１２と半田ボール１８との結合力が充分でないため、半田ボール１８にクラックを生じたり、台座１２が素子本体１４から剥がれたり、素子本体１４が欠けるなどして充分な信頼性を得ることができない。

【０００７】本発明は、前記従来技術の欠点を解消するためになされたもので、実装の際に半田ボールに作用する剪断応力を緩和することを目的としている。

【０００８】また、本発明は、半田ボールと台座との結合力を大きくすることを目的としている。

【０００９】

【課題を解決するための手段】上記の目的を達成するために、本発明に係る半導体装置は、外部接続端子に半田ボールを固着した半導体装置において、前記半田ボールを固着する台座の表面に凸部または凹部を形成した構成となっている。このように構成した半導体装置は、半田ボールを溶融して半導体装置を基板に実装したときに、半導体装置と実装基板との熱膨張率の相違による半田（半田ボール）に作用する剪断応力により凸部、または凹部を形成している周囲の凸状部が変形することにより剪断応力の一部を吸収するため、剪断応力が緩和され、半田にクラックが生じたり、または台座が剥がれたり半導体装置に欠けを生じたりするのを防止することができる。また、台座に凸部または凹部を形成したことにより、台座と半田ボールとの結合面積（接触面積）を大きくなって両者の結合力が大きくなるとともに、半田に作用する剪断応力を分散することができ、半田にクラックなどが生ずるのを防止することができる。

【００１０】凸部または凹部を複数設けることにより、台座と半田ボールとの結合面積をより大きくなって両者の結合力を高めることができる。複数の凸部を剣山状に、すなわち凸部のアスペクトを大きくすると、半田に作用する剪断応力によって凸部が容易に撓むため、剪断応力の緩和効果をより大きくすることができる。また、台座を茸状に形成すると、台座全体が撓んで半田に作用する剪断応力を緩和することができるばかりでなく、台座に傘部が形成されるため、剪断応力によって半田が台座から剥離するようなことがない。

【００１１】そして、上記の半導体装置を製造する方法は、外部端子を有する能動面に導電性金属層を形成する工程と、前記金属層の上に第１のレジスト膜を設けてパターニングし、前記外部端子に対応した部分以外の前記金属層を露出させる工程と、前記金属層の露出部をエッチングして除去したのち、第１のレジスト膜を取り去る外部端子位置に前記金属層からなる台座を形成する工程と、前記能動面の上部に第２のレジスト膜を設けてパターニングし、前記台座の上の一部にのみ前記第２のレジスト膜を残す工程と、前記台座をハーフエッチングしたのち、第２のレジスト膜を除去して台座の上面に凸部または凹部を形成する工程と、前記台座を覆って半田ボールを設ける工程と、を有する構成にしてある。これにより、台座の上面に凹凸が形成され、台座と半田ボールとの接触面積が大きくなって両者の結合力を向上できるとともに、実装時に半田に作用する剪断能力を緩和することができる。

【００１２】また、本発明に係る半導体装置の製造方法は、外部端子を有する能動面に導電性金属層を形成する工程と、前記金属層の上に第１のレジスト膜を設けてパターニングし、前記外部端子と対応した部分の一部にのみ第１のレジスト膜を残す工程と、前記金属層をハーフエッチングしたのち、前記第１のレジスト膜を除去する工程と、前記能動面の上部に第２のレジスト膜を設けてパターニングし、前記外部端子に対応した部分以外の前記金属層を露出させる工程と、前記金属層の露出部をエッチングして除去したのち、第２のレジスト膜を取り去って外部端子位置に凸部または凹部を有する台座を形成する工程と、前記台座を覆って半田ボールを設ける工程と、を有する構成にした。

【００１３】さらに、本発明に係る半導体装置の製造方法は、外部端子を有する能動面に導電性金属薄膜を形成する工程と、前記金属薄膜の上に第１のレジスト膜を設けてパターニングし、前記外部端子に対応した部分の前記金属薄膜を露出させる工程と、前記金属薄膜の露出部に導電性金属を堆積して金属堆積層を形成したのち、前記第１のレジスト膜を除去する工程と、前記能動面の上部に第２のレジスト膜を形成してパターニングし、前記金属堆積層の一部にのみ前記第２のレジスト膜を残す工程と、前記金属堆積層の露出部をハーフエッチングするとともに、前記金属薄膜の露出部をエッチングして除去

したのち、前記第２のレジスト膜を取り去って外部端子位置に凸部または凹部を有する台座を形成する工程と、前記台座を覆って半田ボールを設ける工程と、を有する構成となっている。

【００１４】さらに、本発明に係る半導体装置の製造方法は、外部端子を有する能動面に導電性金属薄膜を形成する工程と、前記金属薄膜の上に第１のレジスト膜を設けてパターニングし、前記外部端子に対応した部分以外の前記金属薄膜を露出させる工程と、前記金属薄膜の露出部をエッチングして除去したのち、前記第１のレジスト膜を取り除く工程と、前記能動面の上部に第２のレジスト膜を設けてパターニングし、前記外部端子と対応した位置の前記金属薄膜を露出させる工程と、露出させた前記金属薄膜の上に導電性金属を前記第２のレジスト膜の上部までメッキしたのち、第２のレジスト膜を除去して外部端子位置にメッキした前記導電性金属による台座を形成する工程と、前記台座を覆って半田ボールを設ける工程と、を有する構成にしてある。これにより、茸状の台座を形成することができ、台座と半田ボールとの結合力を高めることができ、また実装時における半田に作用する剪断応力の緩和とことができる。

【００１５】

【発明の実施の形態】本発明に係る半導体装置およびその製造方法の好ましい実施の形態を、添付図面に従って詳細に説明する。

【００１６】図１は、本発明の実施の形態に係る半導体装置の要部説明図であって、（ａ）はその断面図、（ｂ）は台座の平面図であり、（Ｃ）、（ｄ）はそれぞれ台座に形成した凹凸の他の例を示す平面図である。

【００１７】図１（ａ）において、半導体装置となる半導体素子３０は、能動面の外部端子に銅からなる台座３２が形成してあるとともに、台座３２の周囲にソルダレジスト１６が設けてあって、台座３２とソルダレジスト１６との間に間隙２０が形成されている。そして、台座３２には、上面と側面とを覆うように半田ボール１８が固着してある。また、台座３２は、上面に複数の凸部３４が形成してあって、半田ボール１８との接触面積（結合面積）が大きくしてある。凸部３４と、凸部間の凹部３６とは、同図（ｂ）に示したように、帯状に形成してある。そして、この実施の形態の場合、台座３２の直径が２００～３００μｍ程度の大きさとなっていて、凸部３４と凹部３６とは、幅が同じに形成してあって、幅の寸法が２０～５０μｍにしてある。

【００１８】このように構成した実施の形態においては、リフロー炉などによって半田ボールを溶融して半導体素子３０を図示しない実装基板に実装した場合、冷却時に半導体素子３０と実装基板との熱膨張率の相違によって半田（半田ボール１８）に剪断応力が作用すると、凸部３４が撓み変形して剪断応力の一部を吸収し、剪断応力を緩和する。このため、半田にクラックが発生したり、台座３２が素子本体１４から剥がれたり、素子本体１４が欠けたりするのを防止することができる。しかも、台座３２の上面に複数の凹凸を設けたことにより、台座３２と半田ボール１８との結合面積を大幅に大きくなって両者の結合力が増し、半田が剥離するなどの事故をなくすことができるばかりでなく、半田に作用する剪断応力を分散でき、半田にクラックが生ずるのを防止できる。

【００１９】なお、台座３２に形成する凸部３４（または凹部３６）は、同図（ｃ）に示したように市松模様状に形成してもよいし、同図（ｄ）に示したように同心円状に形成してもよい。そして、前記実施の形態においては、半導体素子３０の外部端子に凹凸を有する台座３２を設けた場合について説明したが、ＢＧＡなどのパッケージの外部接続端子に対しても適用することができる。

【００２０】図２（ａ）～（ｄ）は、台座の他の実施形態の示したものである。図２（ａ）に示した台座４０は、上面の中心部に円柱状の凸部４２が形成してある。この台座４０においては、半田に剪断応力が作用すると、中心部の凸部４２が撓んで剪断応力の一部を吸収して応力を緩和する。さらに、同図（ｂ）に示した台座４４は、上面の中央部が凹部４６となっていて、周縁部が凸部４８となっている。そして、この台座４４は、半田に剪断応力が作用すると、周縁部の凸部４８が変形して剪断応力を吸収、緩和する。

【００２１】図２（ｃ）に示した台座５０は、軸部５２と軸部５２の上部に傘部５４とを有する茸状に形成してある。この台座５０は、全体が撓むことによって剪断応力を緩和する。なお、台座５０は、詳細を後述するように、メッキによって容易に形成することができる。

【００２２】図２（ｄ）に示した台座６０は、凹部６２と凸部６４とを交互に形成するとともに、凹部６２を深く形成してアスペクト比を大きくし、いわゆる剣山状に形成したものである。この台座６０は、実施の形態の場合、直径Ｄが２００～３００μｍであって、素子本体１４の表面からの基部６６の高さｈが５～２０μｍ、凸部６４の高さ（凹部６２の深さ）Ｈが２０～１００μｍ、凸部６４の一辺の長さＬが２０～５０μｍに形成してある。これにより、凸部６４が半田に作用する剪断応力によって容易に撓むため、大きな応力緩和効果を得ることができる。

【００２３】図３は、上記した半導体素子３０の製造方法の実施形態の一例を示した説明図である。まず、同図（ａ）に示したように、素子本体１４の能動面に銅層７０を堆積する。この銅層７０は、実施の形態の場合、素子本体１４の表面にスパッタリングにより１０００～７０００オングストローム程度の銅の薄膜を形成したのち、銅の薄膜の上に銅メッキを所定の厚さ堆積したもので、全体として５０～１００μｍ程度の厚さを有している。

【００２４】その後、銅層７０の表面に第１のレジスト膜であるフォトレジスト７２を塗布し、パターニングして素子の外部端子に対応した台座を形成する部分以外のフォトレジスト７２を除去して銅層７０を露出させる（同図（ｂ））。次に、露出させた銅層７０をエッチングして銅からなる台座３２を形成したのち（同図（ｃ））、台座３２の上に残っていたフォトレジスト７２を除去する（同図（ｄ））。さらに、図３（ｅ）に示したように、素子本体１４の上部に第２のレジスト膜であるフォトレジスト７４を塗布してパターニングし、台座３２の上の凸部を形成する部分にだけフォトレジスト７４を残す。その後、台座３２をハーフエッチングして凹部３６を所定の深さに形成し、フォトレジスト７４を除去して上面に凸部３４と凹部３６とが形成された台座３２にする（同図（ｆ））。次に、同図（ｇ）に示したように、台座３２を覆って半田ボール１８を設けて半導体素子３０とする。

【００２５】なお、必要に応じて台座３２のと素子本体１４との間に、クロム（Ｃｒ）やチタン（Ｔｉ）、チタンータングステン合金（ＴｉＷ）、またはニッケル（Ｎｉ）などのバリアメタルを設けることができる。

【００２６】図４は、製造方法の他の実施形態を示したものである。この製造方法は、まず素子本体１４の表面に前記と同様にして銅層７０を所定の厚さ堆積したのち（図４（ａ））、銅層７０の表面に第１のレジスト膜であるフォトレジスト７２を塗布してパターニングし、台座の凸部に対応した部分のフォトレジスト７２のみを残す（同図（ｂ））。その後、銅層７０の露出している部分をハーフエッチングしたのち、残っているフォトレジスト７２を除去して台座を設ける位置に凸部３４と凹部３６とを形成する（同図（ｃ））。次に、同図（ｄ）に示したように、銅層７０の表面に第２のレジスト膜となるフォトレジスト７４を塗布し、パターニングして台座を形成する部分以外のフォトレジスト７４を除去して銅層７０を露出させる。次に、露出した銅層７０をエッチングして除去したのち、台座形成部のフォトレジスト７４を除去して凹凸を有する台座３２を形成する（同図（ｅ））。その後、同図（ｆ）に示したように、台座３２を覆って半田ボール１８を設ける。

【００２７】図５は、さらに他の実施の形態に係る半導体装置の製造方法を示したものである。この製造方法は、図５（ａ）に示したように、まず素子本体１４の表面にスパッタリングによって銅の薄膜７６を形成する。この銅薄膜７６の厚さは、１０００～７０００オングストロームであってよい。その後、銅薄膜７６の上にフォトレジスト７２を塗布してパターニングし、台座を形成する位置のフォトレジスト７２を除去する（同図（ｂ））。さらに、同図（ｃ）に示したように、フォトレジスト７２を除去した部分に銅をメッキしてメッキ層７８を形成したのち、フォトレジスト７２を除去する（同図（ｄ））。

【００２８】次に、図５（ｅ）に示したように、素子本体１４の上部にフォトレジスト７４を塗布してパターニングし、銅メッキ層７８に形成する凸部に対応した部分にのみフォトレジスト７４を残す。そして、露出している銅薄膜７６をエッチングして除去するとともに、銅メッキ層７８をハーフエッチングしたのち、銅メッキ層７８上のフォトレジスト７４を除去し、上面に凸部３４と凹部３６とを有する台座３２を形成する（同図（ｆ））。その後、前記と同様にして台座３２を覆って半田ボール１８を設けて半導体素子３０を完成させる。

【００２９】図６は、茸状の台座を有する半導体装置の製造方法の実施形態を示したものである。まず、図６（ａ）に示したように、素子本体１４の表面にスパッタリングによって銅の薄膜７６を形成する。次に、銅薄膜７６の上に第１のレジスト膜となるフォトレジスト７２を塗布してパターニングし、素子本体１４の外部端子と対応した部分以外の銅薄膜７６を露出させる（同図（ｂ））。その後、同図（ｃ）に示したように、銅薄膜７６の露出部をエッチングして除去したのち、外部端子との対応位置に残したフォトレジスト膜７２を除去する。さらに、素子本体１４の上部に第２のレジスト膜となるフォトレジスト７４を塗布してパターニングし、銅薄膜７６上部のフォトレジスト７４を除去して銅薄膜７６を露出させる（同図（ｄ））。

【００３０】次に、露出させた銅薄膜７６の上に銅のメッキを施して銅メッキ層８０を形成する（図６（ｅ））。この銅メッキ層８０は、図に示されているように、フォトレジスト７４の上部に盛り上がるまで行なう。これにより、銅メッキ層８０は、フォトレジスト７４の上面の孔８２の周囲に広がって茸状になる。そして、銅のメッキ層８０が茸状に形成されたならば、洗浄、乾燥したのち、フォトレジスト７４を除去し、茸状の台座５０を形成する。その後、台座５０を覆って半田ボール１８を設ける。

【００３１】

【発明の効果】以上に説明したように、本発明によれば、半田ボールを固着する台座に凸部または凹部を設けたことにより、半田ボールを溶融して半導体装置を基板に実装したときに、半導体装置と実装基板との熱膨張率の相違による半田（半田ボール）に作用する剪断応力により凸部、または凹部を形成している周囲の凸状部が変形して剪断応力の一部を吸収するため、剪断応力が緩和され、半田にクラックが生じたり、または台座が剥がれたり半導体装置に欠けを生じたりするのを防止することができる。また、台座に凸部または凹部を形成したことにより、台座と半田ボールとの結合面積（接触面積）を大きくなって両者の結合力が大きくなるとともに、半田に作用する剪断応力を分散することができ、半田にクラックなどが生ずるのを防止することができる。

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【図面の簡単な説明】

【図１】本発明の実施の形態に係る半導体装置の要部説明図である。

【図２】本発明の他の実施形態に係る台座の説明図である。

【図３】実施の形態に係る半導体装置の製造方法の一例を示す説明図である。

【図４】他の実施形態に係る半導体装置の製造方法の説明図である。

【図５】さらに他の実施の形態に係る半導体装置の製造方法の説明図である。

【図６】実施の形態に係る茸状台座を有する半導体装置の製造方法の説明図である。

【図７】従来の半田ボールを有する半導体素子の要部説明図である。

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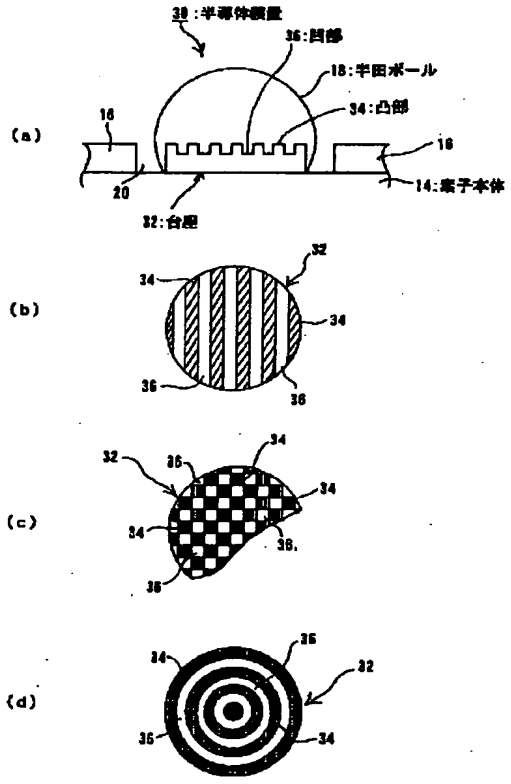
【図８】半田ボールを設けた従来の他の半導体素子の要部説明図である。

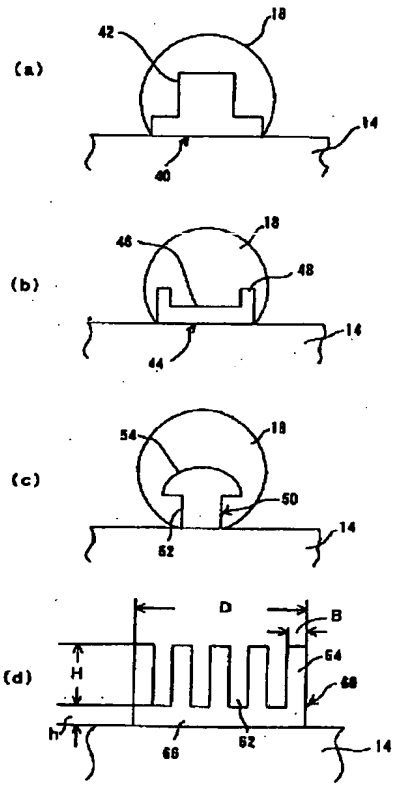
【符号の説明】

１４	素子本体
１８	半田ボール
３０	半導体素子
３２	台座
３４	凸部
３６	凹部
４０、４４、５０、６０	台座
４２、４８、６４	凸部
４６、６２	凹部

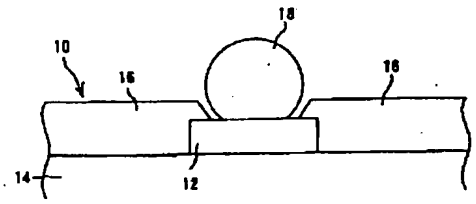
【図１】



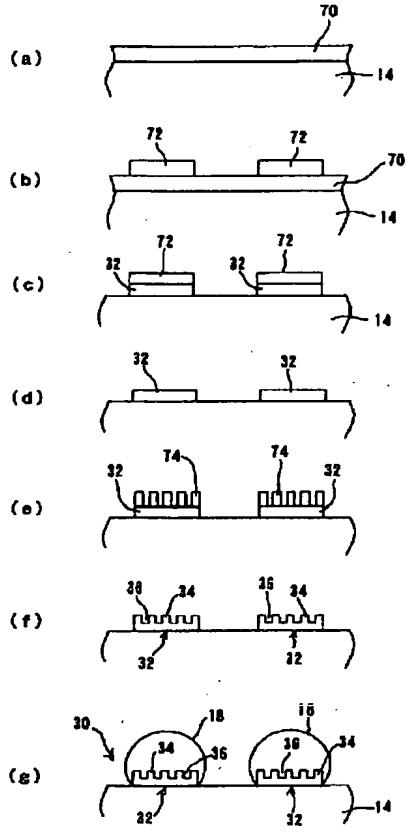
【図２】



【図７】



【図３】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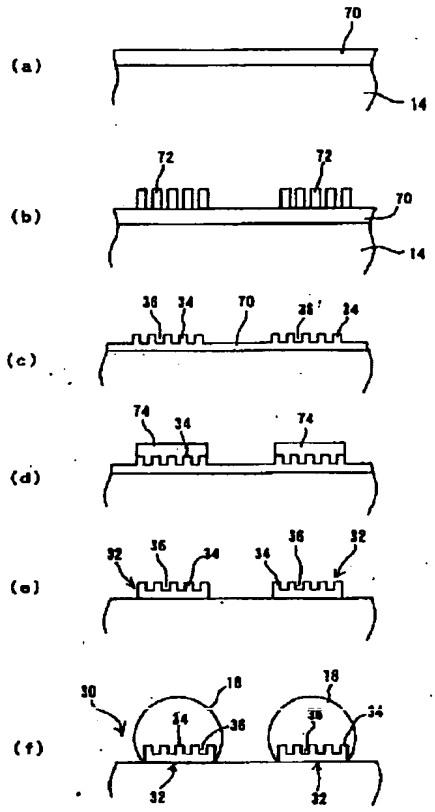
【図４】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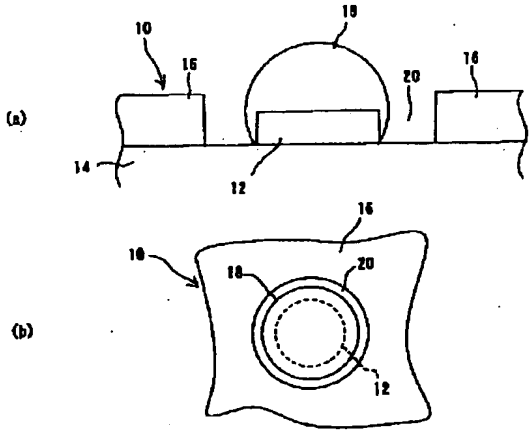
【図８】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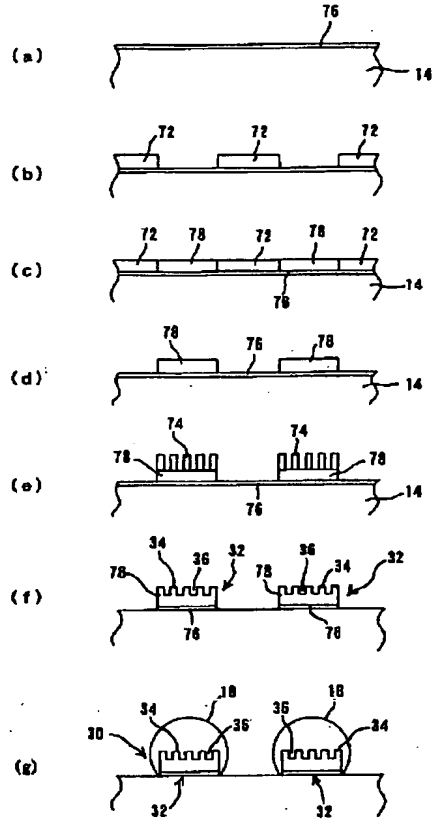
【図５】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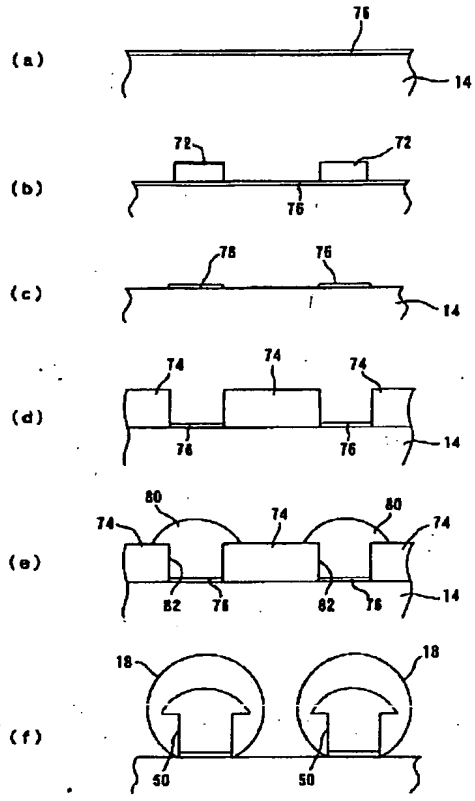
【図６】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(71)Applicant : SEIKO EPSON CORP

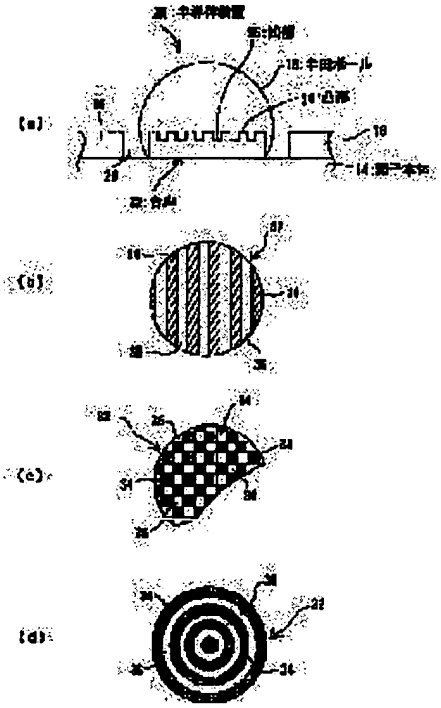
(72)Inventor : HANAOKA TERUNAO

(54) SEMICONDUCTOR DEVICE AND ITS MANUFACTURE

(57)Abstract:

PROBLEM TO BE SOLVED: To relax shear stress acting on solder balls when a semiconductor device is mounted.

SOLUTION: A semiconductor device 30 is equipped with a pad 32 of copper on the outer terminal of a device main body 14, and a solder ball 18 is provided covering the pad 32. The pad 32 is possessed of projections 34 and recesses 36 on its upside. These projections 34 and recesses 36 are formed like belts, a checkered pattern or concentric circles, so that a joint surface between the pad 32 and the solder ball 18 is enhanced in area. The projections 34 are deflected and deformed by shear stress imposed on solder (solder ball 18) to relax the shear stress absorbing it partly when the solder ball 18 is melted and the semiconductor device 30 is mounted on a board.



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[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

* NOTICES *

1. This document has been translated by computer.So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The semiconductor device characterized by forming heights or a crevice in the front face of the plinth which fixes the aforementioned solder ball in the semiconductor device which fixed the solder ball to the external end-connection child.
[Claim 2] The aforementioned heights or the aforementioned crevice is a semiconductor device according to claim 1 characterized by having prepared more than one.
[Claim 3] Two or more aforementioned heights are semiconductor devices according to claim 2 characterized by having formed in the shape of a needle point holder.
[Claim 4] the aforementioned plinth -- a mushroom -- the semiconductor device according to claim 1 characterized by having formed in a **
[Claim 5] The manufacture method of a semiconductor device characterized by providing the following. The process which forms a conductive metal layer in the active side which has an external terminal. The process at which patterning of the 1st resist film is prepared and carried out on the aforementioned metal layer, and the aforementioned metal layers other than the portion corresponding to the aforementioned external terminal are exposed. The process which forms the plinth which consists of the aforementioned metal layer in the external terminal position which removes the 1st resist film after **********ing and removing the outcrop of the aforementioned metal layer. The process which prepares and carries out patterning of the 2nd resist film to the upper part of the aforementioned activity side, and leaves the resist film of the above 2nd only to the part on the aforementioned plinth, the process which removes the 2nd resist film after carrying out half etching of the aforementioned plinth, and forms heights or a crevice in the upper surface of a plinth, and the process which covers the aforementioned plinth and prepares a solder ball.
[Claim 6] The manufacture method of a semiconductor device characterized by providing the following. The process which forms a conductive metal layer in the active side which has an external terminal. The process which prepares and carries out patterning of the 1st resist film on the aforementioned metal layer, and leaves the 1st resist film to the aforementioned external terminal and a part of corresponding portion. The process which removes the resist film of the above 1st after carrying out half etching of the aforementioned metal layer. The process which forms the plinth which removes the 2nd resist film after **********ing and removing the process at which patterning of the 2nd resist film is prepared and carried out to the upper part of the aforementioned activity side, and the aforementioned metal layers other than the portion corresponding to the aforementioned external terminal are exposed, and the outcrop of the aforementioned metal layer, and has heights or a crevice in an external terminal position, and the process which cover the aforementioned plinth and prepare a solder ball.
[Claim 7] The manufacture method of a semiconductor device characterized by providing the following. The process which forms a conductive metal thin film in the active side which has an external terminal. The process at which patterning of the 1st resist film is prepared and carried out on the aforementioned metal thin film, and the aforementioned metal thin film of the portion corresponding to the aforementioned external terminal is exposed. The process which removes the resist film of the above 1st after depositing a conductive metal on the outcrop of the aforementioned metal thin film and forming a metal deposit. While forming and carrying out patterning of the 2nd resist film to the upper part of the aforementioned activity side and carrying out half etching of the process which leaves the resist film of the above 2nd to a part of aforementioned metal deposit, and the outcrop of the aforementioned metal deposit The process which forms the plinth which removes the resist film of the above 2nd and has heights or a crevice in an external terminal position after **********ing and removing the outcrop of the aforementioned metal thin film, and the process which covers the aforementioned plinth and prepares a solder ball.
[Claim 8] The manufacture method of a semiconductor device characterized by providing the following. The process which forms a conductive metal thin film in the active side which has an external terminal. The process at which

patterning of the 1st resist film is prepared and carried out on the aforementioned metal thin film, and the aforementioned metal thin films other than the portion corresponding to the aforementioned external terminal are exposed. The process which removes the resist film of the above 1st after **********ing and removing the outcrop of the aforementioned metal thin film. The process at which patterning of the 2nd resist film is prepared and carried out to the upper part of the aforementioned activity side, and the aforementioned external terminal and the aforementioned corresponding metal thin film of a position are exposed, The process which forms the plinth by the aforementioned conductive metal which removed the 2nd resist film and was plated in the external terminal position after plating a conductive metal to the upper part of the resist film of the above 2nd on the exposed aforementioned metal thin film, and the process which covers the aforementioned plinth and prepares a solder ball.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the semiconductor device which was applied to the semiconductor device, especially fixed the solder ball to the external end-connection child like a ball grid array (BGA), and its manufacture method.
[0002]
[Description of the Prior Art] In recent years, high integration of a semiconductor device and the miniaturization are demanded strongly, and development of the package of the size which is a chip grade, and the so-called chip-size package (CSP) is performed. In such a small package, in order to attain many pin(many-items child)-ization, the external end-connection child has been stationed in the shape of a matrix to the semiconductor device or the active side of a package, and the solder ball is fixed to the external end-connection child. Drawing 7 shows a part of conventional semiconductor device which has a solder ball.
[0003] the drawing 7 **** -- the plinth 12 is formed in the position where the semiconductor device 10 corresponded with the external end-connection child of the front face of the element main part 14 by the copper thin layer Moreover, the solder resist 16 which has covered the periphery section of a plinth 12 is formed in the front face of the element main part 14. And the solder ball 18 is fixed into the portion which is not covered by the solder resist 16 of a plinth 12.
[0004] By the way, in semiconductor devices, such as CSP, in order to attain high integration and many pin-ization, the size of a plinth 12 or the solder ball 18 is restrained by about 200-300 micrometers for a diameter. For this reason, when the plane-of-composition product of a plinth 12 and the solder ball 18 becomes small, both bonding strength is insufficient and a semiconductor device 10 is mounted in a substrate, big shearing stress acts on the solder ball 18 from the difference of coefficient of thermal expansion with a semiconductor chip 10 and a mounting substrate, and the problem on which the solder ball 18 exfoliates from a plinth 12 is produced. Then, in order to heighten the bonding strength of the solder ball 18 and a plinth 12, the terminal of structure like drawing 8 is proposed.
[0005] That is, a gap 20 is formed between a plinth 12 and solder RESHIZUTO 16, without putting a solder resist 16 on a plinth 12, and while the lower part of the solder ball 18 is wearing the side of a plinth 12 and enlarges the plane-of-composition product of the solder ball 18 and a plinth 12, it is made for the element main part 14 to receive the shearing stress which acts on the solder ball 18 through a plinth 12 in the case of mounting.
[0006]
[Problem(s) to be Solved by the Invention] However, it sets to the above-mentioned conventional semiconductor device. Since [which may have the structure which eases the shearing stress which transmits the shearing stress which acts on the solder ball 18 to the element main part 14 through a plinth 12, and acts on the solder ball 18 in the case of mounting to the substrate of a semiconductor device 10] there is nothing, Moreover, since the bonding strength of a plinth 12 and the solder ball 18 is not enough, a crack cannot be produced on the solder ball 18, or a plinth 12 cannot separate from the element main part 14, or the element main part 14 is missing and sufficient reliability cannot be acquired.
[0007] this invention was made in order to cancel the fault of the aforementioned conventional technology, and it aims at easing the shearing stress which acts on a solder ball in the case of mounting.
[0008] Moreover, this invention aims at enlarging bonding strength of a solder ball and a plinth.
[0009]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, the semiconductor device concerning this invention has the composition in which heights or the crevice was formed on the front face of the plinth which fixes the aforementioned solder ball, in the semiconductor device which fixed the solder ball to the external end-connection child. Thus, when a solder ball is fused and a semiconductor device is mounted in a substrate, the

constituted semiconductor device When the height of the circumference which forms heights or the crevice by the shearing stress which acts on the solder (solder ball) by the difference of coefficient of thermal expansion with a semiconductor device and a mounting substrate deforms, in order to absorb a part of shearing stress, Shearing stress is eased and it can prevent a crack arising in solder, or a plinth separating, or producing a chip in a semiconductor device. Moreover, while it becomes large about the plane-of-union product (touch area) of a plinth and a solder ball and both bonding strength becomes large by having formed heights or the crevice in the plinth, the shearing stress which acts on solder can be distributed and it can prevent that a crack etc. arises in solder.

[0010] By preparing two or more heights or crevices, it becomes larger about the plane-of-union product of a plinth and a solder ball, and both bonding strength can be heightened. If a needle point holder-like, i.e., heights, aspect is enlarged for two or more heights, since heights will bend easily by the shearing stress which acts on solder, the relaxation effect of shearing stress can be enlarged more. moreover, a plinth -- a mushroom -- solder seems not to exfoliate from a plinth by shearing stress, since it not only can ease the shearing stress which the whole plinth bends and acts on solder, but an umbrella part will be formed in a plinth, if it forms in a **

[0011] And the method of manufacturing the above-mentioned semiconductor device The process at which patterning of the 1st resist film is prepared and carried out to the process which forms a conductive metal layer in the active side which has an external terminal on the aforementioned metal layer, and the aforementioned metal layers other than the portion corresponding to the aforementioned external terminal are exposed, The process which forms the plinth which consists of the aforementioned metal layer in the external terminal position which removes the 1st resist film after **********ing and removing the outcrop of the aforementioned metal layer, The process which prepares and carries out patterning of the 2nd resist film to the upper part of the aforementioned activity side, and leaves the resist film of the above 2nd only to the part on the aforementioned plinth, After carrying out half etching of the aforementioned plinth, it is made the composition which has the process which removes the 2nd resist film and forms heights or a crevice in the upper surface of a plinth, and the process which covers the aforementioned plinth and prepares a solder ball. While irregularity is formed in the upper surface of a plinth, and the touch area of a plinth and a solder ball becomes large and being able to improve both bonding strength by this, the shearing capacity to act on solder at the time of mounting can be eased.

[0012] Moreover, the manufacture method of the semiconductor device concerning this invention The process which prepares and carries out patterning of the 1st resist film the process which forms a conductive metal layer in the active side which has an external terminal, and on the aforementioned metal layer, and leaves the 1st resist film to a part of aforementioned external terminal and corresponding portion, The process which removes the resist film of the above 1st after carrying out half etching of the aforementioned metal layer, The process at which patterning of the 2nd resist film is prepared and carried out to the upper part of the aforementioned activity side, and the aforementioned metal layers other than the portion corresponding to the aforementioned external terminal are exposed, After **********ing and removing the outcrop of the aforementioned metal layer, it was made the composition which has the process which forms the plinth which removes the 2nd resist film and has heights or a crevice in an external terminal position, and the process which covers the aforementioned plinth and prepares a solder ball.

[0013] Furthermore, the manufacture method of the semiconductor device concerning this invention The process which forms a conductive metal thin film in the active side which has an external terminal, and the process at which patterning of the 1st resist film is prepared and carried out on the aforementioned metal thin film, and the aforementioned metal thin film of the portion corresponding to the aforementioned external terminal is exposed, The process which removes the resist film of the above 1st after depositing a conductive metal on the outcrop of the aforementioned metal thin film and forming a metal deposit, While forming and carrying out patterning of the 2nd resist film to the upper part of the aforementioned activity side and carrying out half etching of the process which leaves the resist film of the above 2nd to a part of aforementioned metal deposit, and the outcrop of the aforementioned metal deposit After **********ing and removing the outcrop of the aforementioned metal thin film, it has the composition of having the process which forms the plinth which removes the resist film of the above 2nd and has heights or a crevice in an external terminal position, and the process which covers the aforementioned plinth and prepares a solder ball.

[0014] Furthermore, the manufacture method of the semiconductor device concerning this invention The process at which patterning of the 1st resist film is prepared and carried out to the process which forms a conductive metal thin film in the active side which has an external terminal on the aforementioned metal thin film, and the aforementioned metal thin films other than the portion corresponding to the aforementioned external terminal are exposed, The process which removes the resist film of the above 1st after **********ing and removing the outcrop of the aforementioned metal thin film, The process at which patterning of the 2nd resist film is prepared and carried out to the upper part of the aforementioned activity side, and the aforementioned external terminal and the aforementioned corresponding

metal thin film of a position are exposed, The process which forms the plinth by the aforementioned conductive metal which removed the 2nd resist film and was plated in the external terminal position after plating a conductive metal to the upper part of the resist film of the above 2nd on the exposed aforementioned metal thin film, It is made the composition which has the process which covers the aforementioned plinth and prepares a solder ball. thereby -- a mushroom -- the relief and thing of shearing stress which can form the plinth of a **, and can heighten the bonding strength of a plinth and a solder ball, and act on the solder at the time of mounting are made

[0015]

[Embodiments of the Invention] The gestalt of desirable operation of the semiconductor device concerning this invention and its manufacture method is explained in detail according to an accompanying drawing.

[0016] Drawing 1 is important section explanatory drawing of the semiconductor device concerning the gestalt of operation of this invention, (a) is the cross section, (b) is the plan of a plinth, and (C) and (d) are the plans showing other examples of the irregularity formed in the plinth, respectively.

[0017] In drawing 1 (a), while having formed the plinth 32 to which the semiconductor device 30 used as a semiconductor device turns into an external terminal of an active side from copper, the solder resist 16 is formed in the circumference of a plinth 32, and the gap 20 is formed between the plinth 32 and the solder resist 16. And to the plinth 32, the solder ball 18 is fixed so that the upper surface and the side may be worn. Moreover, two or more heights 34 are formed in the upper surface, and, as for the plinth 32, the touch area (plane-of-union product) with the solder ball 18 is enlarged. Heights 34 and the crevice 36 between heights are formed in band-like as shown in this drawing (b). And in the case of the gestalt of this operation, the diameter of a plinth 32 serves as a size which is about 200-300 micrometers, similarly width of face is formed and, as for heights 34 and the crevice 36, the size of width of face is set to 20-50 micrometers.

[0018] Thus, in the gestalt of the constituted operation, if shearing stress acts on solder (solder ball 18) by the difference of coefficient of thermal expansion with a semiconductor device 30 and a mounting substrate at the time of cooling when mounted in the mounting substrate which fuses a solder ball and does not illustrate a semiconductor device 30 at a reflow furnace etc., heights 34 will bend and deform, will absorb a part of shearing stress, and will ease shearing stress. For this reason, it can prevent that a crack occurs in solder, a plinth 32 separates from the element main part 14, or the element main part 14 is missing. And by having prepared two or more irregularity in the upper surface of a plinth 32, it can become large sharply about the plane-of-union product of a plinth 32 and the solder ball 18, both bonding strength not only can abolish the accident of increase and solder exfoliating, but can distribute the shearing stress which acts on solder, and it can prevent that a crack arises in solder.

[0019] In addition, the heights 34 (or crevice 36) formed in a plinth 32 may be formed in the shape of a checker, as shown in this drawing (c), and as shown in this drawing (d), you may form them in the shape of a concentric circle. And in the gestalt of the aforementioned implementation, although the case where the plinth 32 which has irregularity for the external terminal of a semiconductor device 30 was formed was explained, it is applicable also to the external end-connection child of packages, such as BGA.

[0020] drawing 2 (a) - (d) -- other operation gestalten of a plinth -- being shown . As for the plinth 40 shown in drawing 2 (a), the pillar-like heights 42 are formed in the core on top. In this plinth 40, if shearing stress acts on solder, the heights 42 of a core will bend, a part of shearing stress will be absorbed, and stress will be eased. Furthermore, the center section on top is a crevice 46, and, as for the plinth 44 shown in this drawing (b), the periphery section is heights 48. And if shearing stress acts on solder, the heights 48 of the periphery section deform this plinth 44, and it will absorb shearing stress and will ease.

[0021] the mushroom to which the plinth 50 shown in drawing 2 (c) has an umbrella part 54 in the upper part of a shank 52 and a shank 52 -- it has formed in the ** This plinth 50 eases shearing stress, when the whole bends. In addition, a plinth 50 can be easily formed by plating so that a detail may be mentioned later.

[0022] The plinth 60 shown in drawing 2 (d) forms a crevice 62 deeply, enlarges an aspect ratio and forms it in the shape of [so-called] a needle point holder while it forms a crevice 62 and heights 64 by turns. In the case of the gestalt of operation, a diameter D is 200-300 micrometers, and, as for this plinth 60, 20-100 micrometers and length [of one side] L of heights 64 are formed [height h of the base 66 from the front face of the element main part 14] in 20-50 micrometers for 5-20 micrometers and height (depth of crevice 62) H of heights 64. Since heights 64 bend easily by this by the shearing stress which acts on solder, it is big stress.

[0023] Drawing 3 is explanatory drawing having shown an example of the operation gestalt of the above-mentioned manufacture method of a semiconductor device 30. First, as shown in this drawing (a), a copper layer 70 is deposited on the active side of the element main part 14. After this copper layer 70 forms the thin film of about 1000-7000A copper in the front face of the element main part 14 by sputtering in the case of the gestalt of operation, it is that to which predetermined carried out the thickness deposition of the copper coating on the copper thin film, and has the

thickness of about 50-100 micrometers as a whole.
[0024] Then, photoresists 72 other than the portion which applies and carries out patterning of the photoresist 72 which is the 1st resist film to the front face of a copper layer 70, and forms the plinth corresponding to the external terminal of an element in it are removed, and a copper layer 70 is exposed (this drawing (b)). Next, after forming the plinth 32 which **********s the exposed copper layer 70 and consists of copper (this drawing (c)), the photoresist 72 which remained on the plinth 32 is removed (this drawing (d)). Furthermore, as shown in drawing 3 (e), patterning of the photoresist 74 which is the 2nd resist film is applied and carried out to the upper part of the element main part 14, and it leaves a photoresist 74 only to the portion which forms the heights on a plinth 32. Then, half etching of the plinth 32 is carried out, and it is made the plinth 32 which removes a photoresist 74 and by which the crevice 36 was formed in the predetermined depth, and heights 34 and the crevice 36 were formed in the upper surface (this drawing (f)). Next, as shown in this drawing (g), a plinth 32 is covered, the solder ball 18 is formed, and it considers as a semiconductor device 30.
[0025] In addition, barrier metal, such as chromium (Cr), a (Titanium Ti) titanium-tungsten alloy (TiW), or nickel (nickel), can be prepared between a plinth 32's and the element main part 14 if needed.
[0026] Drawing 4 shows other operation gestalten of the manufacture method. After predetermined carries out the thickness deposition of the copper layer 70 like [the front face of the element main part 14] the above first (drawing 4 (a)), this manufacture method applies and carries out patterning of the photoresist 72 which is the 1st resist film to the front face of a copper layer 70, and leaves only the photoresist 72 of the portion corresponding to the heights of a plinth (this drawing (b)). Then, after carrying out half etching of the portion which has exposed the copper layer 70, heights 34 and a crevice 36 are formed in the position in which the photoresist 72 which remains is removed and a plinth is prepared (this drawing (c)). Next, as shown in this drawing (d), photoresists 74 other than the portion which applies and carries out patterning of the photoresist 74 used as the 2nd resist film to the front face of a copper layer 70, and forms a plinth in it are removed, and a copper layer 70 is exposed. Next, after **********ing and removing the exposed copper layer 70, the plinth 32 which removes the photoresist 74 of the plinth formation section and has irregularity is formed (this drawing (e)). Then, as shown in this drawing (f), a plinth 32 is covered and the solder ball 18 is formed.
[0027] Drawing 5 shows the manufacture method of the semiconductor device further applied to the gestalt of other operations. This manufacture method forms the copper thin film 76 in the front face of the element main part 14 by sputtering first, as shown in drawing 5 (a). The thickness of this copper thin film 76 may be 1000-7000A. Then, patterning of the photoresist 72 is applied and carried out on the copper thin film 76, and the photoresist 72 of the position which forms a plinth is removed (this drawing (b)). Furthermore, a photoresist 72 is removed, after plating copper into the portion which removed the photoresist 72 and forming a deposit 78, as shown in this drawing (c) (this drawing (d)).
[0028] Next, as shown in drawing 5 (e), patterning of the photoresist 74 is applied and carried out to the upper part of the element main part 14, and it leaves a photoresist 74 only to the portion corresponding to the heights formed in the copper-coating layer 78. And while **********ing and removing the exposed copper thin film 76, after carrying out half etching of the copper-coating layer 78, the photoresist 74 on the copper-coating layer 78 is removed, and the plinth 32 which has heights 34 and a crevice 36 is formed in the upper surface (this drawing (f)). Then, a plinth 32 is covered like the above, the solder ball 18 is formed, and a semiconductor device 30 is completed.
[0029] drawing 6 -- a mushroom -- the operation form of the manufacture method of a semiconductor device of having the plinth of a ** is shown First, as shown in drawing 6 (a), the copper thin film 76 is formed in the front face of the element main part 14 by sputtering. Next, patterning of the photoresist 72 used as the 1st resist film is applied and carried out on the copper thin film 76, and copper thin films 76 other than the external terminal of the element main part 14 and the corresponding portion are exposed (this drawing (b)). Then, as shown in this drawing (c), after **********ing and removing the outcrop of the copper thin film 76, the photoresist film 72 which it left to the correspondence position with an external terminal is removed. Furthermore, patterning of the photoresist 74 used as the 2nd resist film is applied and carried out to the upper part of the element main part 14, the photoresist 74 of the copper thin film 76 upper part is removed, and the copper thin film 76 is exposed (this drawing (d)).
[0030] Next, on the exposed copper thin film 76, copper is plated and the copper-coating layer 80 is formed (drawing 6 (e)). This copper-coating layer 80 is performed until it rises in the upper part of a photoresist 74 as shown in drawing. thereby -- the copper-coating layer 80 -- the circumference of the hole 82 of the upper surface of a photoresist 74 -- spreading -- a mushroom -- it becomes a ** and the copper deposit 80 -- a mushroom -- the photoresist 74 if formed in a **, after washing and drying -- removing -- a mushroom -- the plinth 50 of a ** is formed Then, a plinth 50 is covered and the solder ball 18 is formed.
[0031]

[Effect of the Invention] By having established heights or the crevice in the plinth which fixes a solder ball according to this invention, as explained above When a solder ball is fused and a semiconductor device is mounted in a substrate, by the shearing stress which acts on the solder (solder ball) by the difference of coefficient of thermal expansion with a semiconductor device and a mounting substrate Heights, Or since the height of the circumference which forms the crevice deforms and a part of shearing stress is absorbed, shearing stress is eased and it can prevent a crack arising in solder, or a plinth separating, or producing a chip in a semiconductor device. Moreover, while it becomes large about the plane-of-union product (touch area) of a plinth and a solder ball and both bonding strength becomes large by having formed heights or the crevice in the plinth, the shearing stress which acts on solder can be distributed and it can prevent that a crack etc. arises in solder.

[Translation done.]

* NOTICES *

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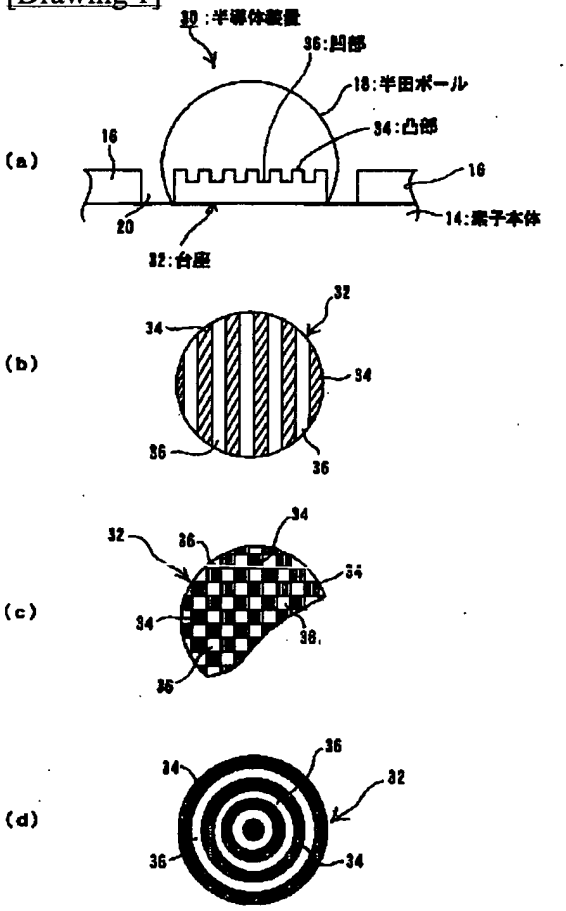
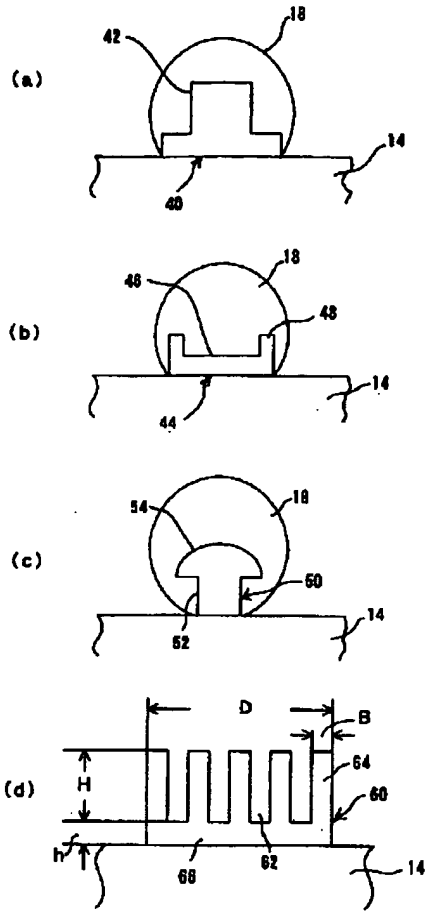
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

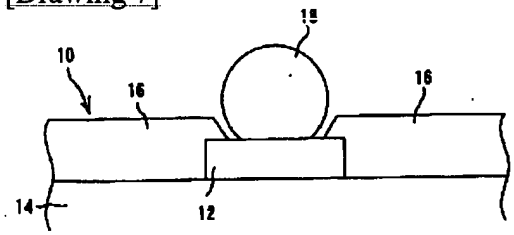
[Drawing 1]



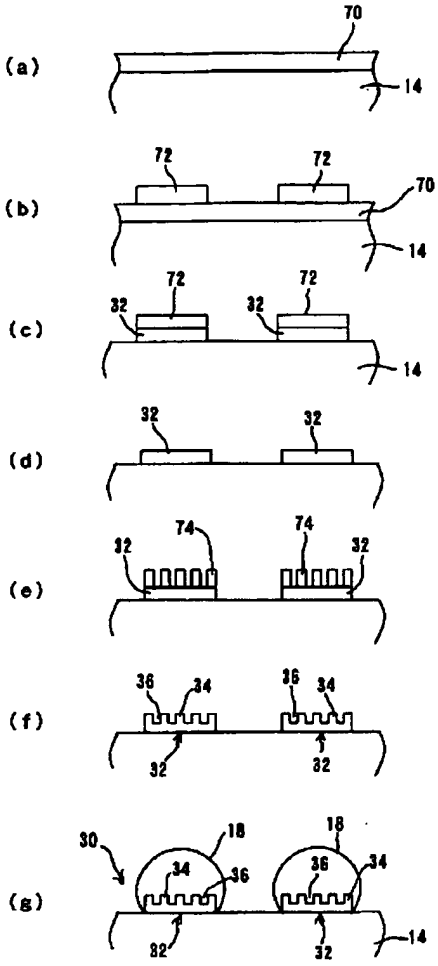
[Drawing 2]



[Drawing 7]



[Drawing 3]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70
14
(b)
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(c)
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(d)
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(e)
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(f)
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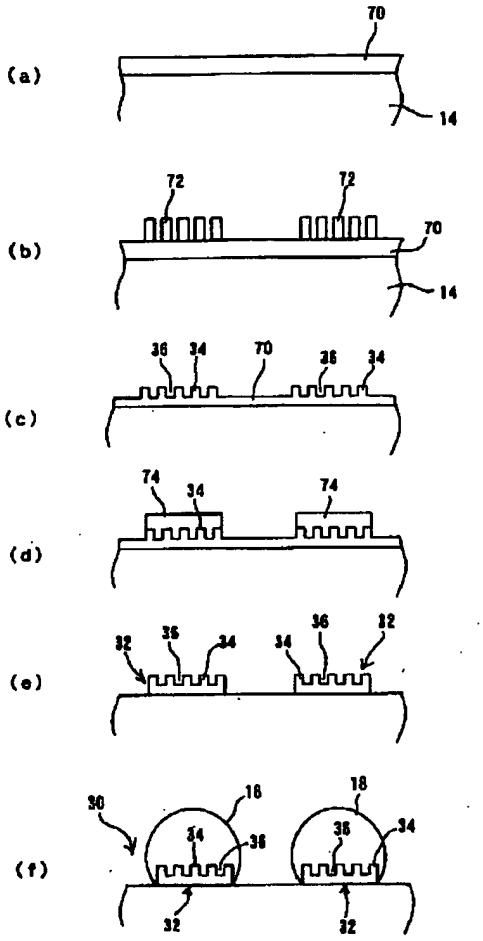
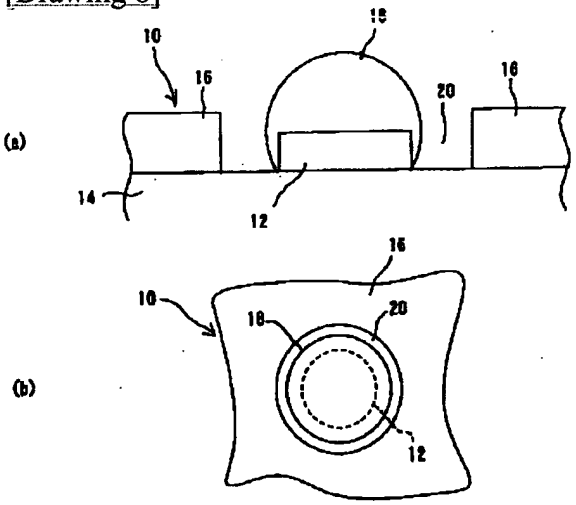
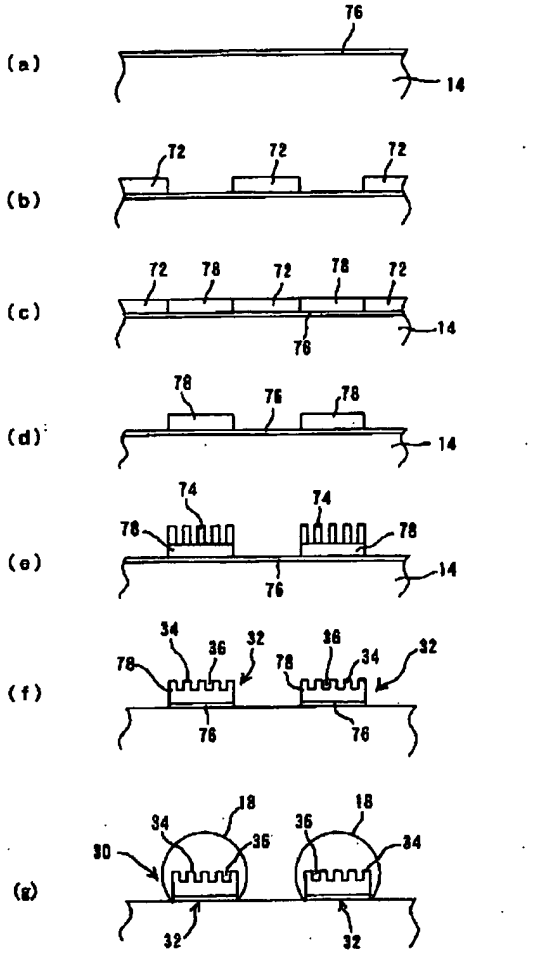
[Drawing 4]



[Drawing 8]



[Drawing 5]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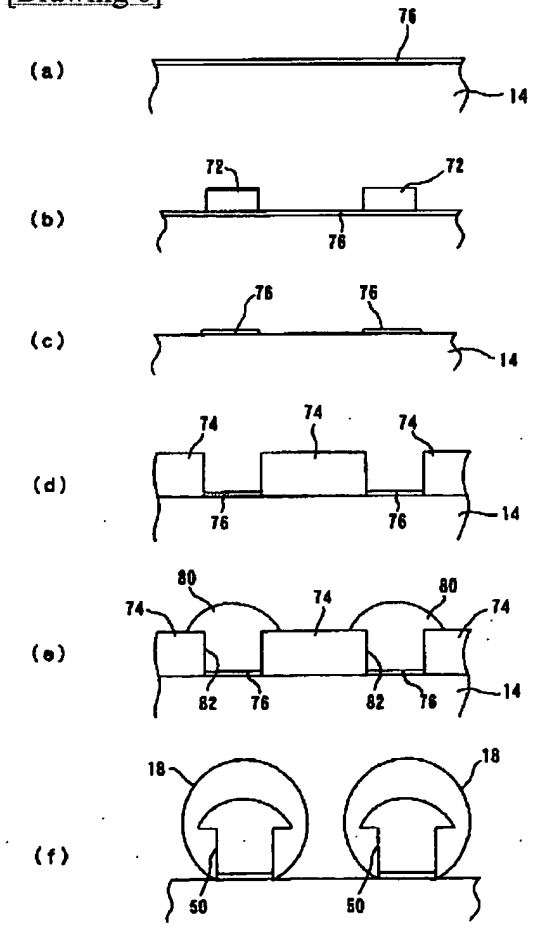
[Drawing 6]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[Translation done.]

PATENT ABSTRACTS OF JAPAN

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(71)Applicant : SEIKO EPSON CORP

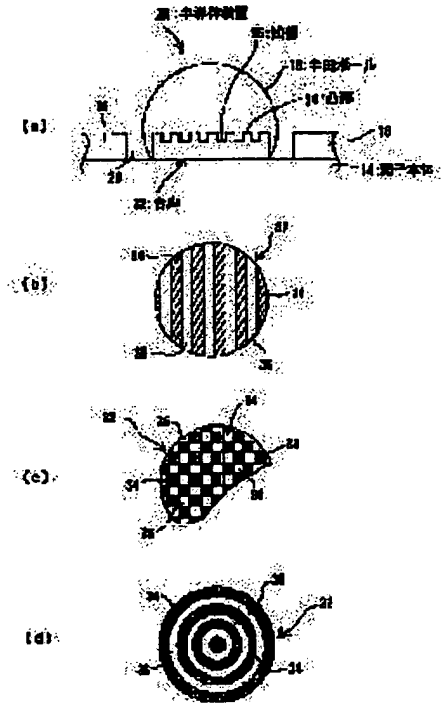
(72)Inventor : HANAOKA TERUNAO

(54) SEMICONDUCTOR DEVICE AND ITS MANUFACTURE

(57)Abstract:

PROBLEM TO BE SOLVED: To relax shear stress acting on solder balls when a semiconductor device is mounted.

SOLUTION: A semiconductor device 30 is equipped with a pad 32 of copper on the outer terminal of a device main body 14, and a solder ball 18 is provided covering the pad 32. The pad 32 is possessed of projections 34 and recesses 36 on its upside. These projections 34 and recesses 36 are formed like belts, a checkered pattern or concentric circles, so that a joint surface between the pad 32 and the solder ball 18 is enhanced in area. The projections 34 are deflected and deformed by shear stress imposed on solder (solder ball 18) to relax the shear stress absorbing it partly when the solder ball 18 is melted and the semiconductor device 30 is mounted on a board.



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[Patent number]

[Date of registration]

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[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

CLAIMS

[Claim(s)]
[Claim 1] The semiconductor device characterized by forming heights or a crevice in the front face of the plinth which fixes the aforementioned solder ball in the semiconductor device which fixed the solder ball to the external end-connection child.
[Claim 2] The aforementioned heights or the aforementioned crevice is a semiconductor device according to claim 1 characterized by having prepared more than one.
[Claim 3] Two or more aforementioned heights are semiconductor devices according to claim 2 characterized by having formed in the shape of a needle point holder.
[Claim 4] the aforementioned plinth -- a mushroom -- the semiconductor device according to claim 1 characterized by having formed in a **
[Claim 5] The manufacture method of a semiconductor device characterized by providing the following. The process which forms a conductive metal layer in the active side which has an external terminal. The process at which patterning of the 1st resist film is prepared and carried out on the aforementioned metal layer, and the aforementioned metal layers other than the portion corresponding to the aforementioned external terminal are exposed. The process which forms the plinth which consists of the aforementioned metal layer in the external terminal position which removes the 1st resist film after **********ing and removing the outcrop of the aforementioned metal layer. The process which prepares and carries out patterning of the 2nd resist film to the upper part of the aforementioned activity side, and leaves the resist film of the above 2nd only to the part on the aforementioned plinth, the process which removes the 2nd resist film after carrying out half etching of the aforementioned plinth, and forms heights or a crevice in the upper surface of a plinth, and the process which covers the aforementioned plinth and prepares a solder ball.
[Claim 6] The manufacture method of a semiconductor device characterized by providing the following. The process which forms a conductive metal layer in the active side which has an external terminal. The process which prepares and carries out patterning of the 1st resist film on the aforementioned metal layer, and leaves the 1st resist film to the aforementioned external terminal and a part of corresponding portion. The process which removes the resist film of the above 1st after carrying out half etching of the aforementioned metal layer. The process which forms the plinth which removes the 2nd resist film after **********ing and removing the process at which patterning of the 2nd resist film is prepared and carried out to the upper part of the aforementioned activity side, and the aforementioned metal layers other than the portion corresponding to the aforementioned external terminal are exposed, and the outcrop of the aforementioned metal layer, and has heights or a crevice in an external terminal position, and the process which cover the aforementioned plinth and prepare a solder ball.
[Claim 7] The manufacture method of a semiconductor device characterized by providing the following. The process which forms a conductive metal thin film in the active side which has an external terminal. The process at which patterning of the 1st resist film is prepared and carried out on the aforementioned metal thin film, and the aforementioned metal thin film of the portion corresponding to the aforementioned external terminal is exposed. The process which removes the resist film of the above 1st after depositing a conductive metal on the outcrop of the aforementioned metal thin film and forming a metal deposit. While forming and carrying out patterning of the 2nd resist film to the upper part of the aforementioned activity side and carrying out half etching of the process which leaves the resist film of the above 2nd to a part of aforementioned metal deposit, and the outcrop of the aforementioned metal deposit The process which forms the plinth which removes the resist film of the above 2nd and has heights or a crevice in an external terminal position after **********ing and removing the outcrop of the aforementioned metal thin film, and the process which covers the aforementioned plinth and prepares a solder ball.
[Claim 8] The manufacture method of a semiconductor device characterized by providing the following. The process which forms a conductive metal thin film in the active side which has an external terminal. The process at which

patterning of the 1st resist film is prepared and carried out on the aforementioned metal thin film, and the aforementioned metal thin films other than the portion corresponding to the aforementioned external terminal are exposed. The process which removes the resist film of the above 1st after **********ing and removing the outcrop of the aforementioned metal thin film. The process at which patterning of the 2nd resist film is prepared and carried out to the upper part of the aforementioned activity side, and the aforementioned external terminal and the aforementioned corresponding metal thin film of a position are exposed, The process which forms the plinth by the aforementioned conductive metal which removed the 2nd resist film and was plated in the external terminal position after plating a conductive metal to the upper part of the resist film of the above 2nd on the exposed aforementioned metal thin film, and the process which covers the aforementioned plinth and prepares a solder ball.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the semiconductor device which was applied to the semiconductor device, especially fixed the solder ball to the external end-connection child like a ball grid array (BGA), and its manufacture method.
[0002]
[Description of the Prior Art] In recent years, high integration of a semiconductor device and the miniaturization are demanded strongly, and development of the package of the size which is a chip grade, and the so-called chip-size package (CSP) is performed. In such a small package, in order to attain many pin(many-items child)-ization, the external end-connection child has been stationed in the shape of a matrix to the semiconductor device or the active side of a package, and the solder ball is fixed to the external end-connection child. Drawing 7 shows a part of conventional semiconductor device which has a solder ball.
[0003] the drawing 7 **** -- the plinth 12 is formed in the position where the semiconductor device 10 corresponded with the external end-connection child of the front face of the element main part 14 by the copper thin layer Moreover, the solder resist 16 which has covered the periphery section of a plinth 12 is formed in the front face of the element main part 14. And the solder ball 18 is fixed into the portion which is not covered by the solder resist 16 of a plinth 12.
[0004] By the way, in semiconductor devices, such as CSP, in order to attain high integration and many pin-ization, the size of a plinth 12 or the solder ball 18 is restrained by about 200-300 micrometers for a diameter. For this reason, when the plane-of-composition product of a plinth 12 and the solder ball 18 becomes small, both bonding strength is insufficient and a semiconductor device 10 is mounted in a substrate, big shearing stress acts on the solder ball 18 from the difference of coefficient of thermal expansion with a semiconductor chip 10 and a mounting substrate, and the problem on which the solder ball 18 exfoliates from a plinth 12 is produced. Then, in order to heighten the bonding strength of the solder ball 18 and a plinth 12, the terminal of structure like drawing 8 is proposed.
[0005] That is, a gap 20 is formed between a plinth 12 and solder RESHIZUTO 16, without putting a solder resist 16 on a plinth 12, and while the lower part of the solder ball 18 is wearing the side of a plinth 12 and enlarges the plane-of-composition product of the solder ball 18 and a plinth 12, it is made for the element main part 14 to receive the shearing stress which acts on the solder ball 18 through a plinth 12 in the case of mounting.
[0006]
[Problem(s) to be Solved by the Invention] However, it sets to the above-mentioned conventional semiconductor device. Since [which may have the structure which eases the shearing stress which transmits the shearing stress which acts on the solder ball 18 to the element main part 14 through a plinth 12, and acts on the solder ball 18 in the case of mounting to the substrate of a semiconductor device 10] there is nothing, Moreover, since the bonding strength of a plinth 12 and the solder ball 18 is not enough, a crack cannot be produced on the solder ball 18, or a plinth 12 cannot separate from the element main part 14, or the element main part 14 is missing and sufficient reliability cannot be acquired.
[0007] this invention was made in order to cancel the fault of the aforementioned conventional technology, and it aims at easing the shearing stress which acts on a solder ball in the case of mounting.
[0008] Moreover, this invention aims at enlarging bonding strength of a solder ball and a plinth.
[0009]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, the semiconductor device concerning this invention has the composition in which heights or the crevice was formed on the front face of the plinth which fixes the aforementioned solder ball, in the semiconductor device which fixed the solder ball to the external end-connection child. Thus, when a solder ball is fused and a semiconductor device is mounted in a substrate, the

constituted semiconductor device When the height of the circumference which forms heights or the crevice by the shearing stress which acts on the solder (solder ball) by the difference of coefficient of thermal expansion with a semiconductor device and a mounting substrate deforms, in order to absorb a part of shearing stress, Shearing stress is eased and it can prevent a crack arising in solder, or a plinth separating, or producing a chip in a semiconductor device. Moreover, while it becomes large about the plane-of-union product (touch area) of a plinth and a solder ball and both bonding strength becomes large by having formed heights or the crevice in the plinth, the shearing stress which acts on solder can be distributed and it can prevent that a crack etc. arises in solder.

[0010] By preparing two or more heights or crevices, it becomes larger about the plane-of-union product of a plinth and a solder ball, and both bonding strength can be heightened. If a needle point holder-like, i.e., heights, aspect is enlarged for two or more heights, since heights will bend easily by the shearing stress which acts on solder, the relaxation effect of shearing stress can be enlarged more. moreover, a plinth -- a mushroom -- solder seems not to exfoliate from a plinth by shearing stress, since it not only can ease the shearing stress which the whole plinth bends and acts on solder, but an umbrella part will be formed in a plinth, if it forms in a **

[0011] And the method of manufacturing the above-mentioned semiconductor device The process at which patterning of the 1st resist film is prepared and carried out to the process which forms a conductive metal layer in the active side which has an external terminal on the aforementioned metal layer, and the aforementioned metal layers other than the portion corresponding to the aforementioned external terminal are exposed, The process which forms the plinth which consists of the aforementioned metal layer in the external terminal position which removes the 1st resist film after **********ing and removing the outcrop of the aforementioned metal layer, The process which prepares and carries out patterning of the 2nd resist film to the upper part of the aforementioned activity side, and leaves the resist film of the above 2nd only to the part on the aforementioned plinth, After carrying out half etching of the aforementioned plinth, it is made the composition which has the process which removes the 2nd resist film and forms heights or a crevice in the upper surface of a plinth, and the process which covers the aforementioned plinth and prepares a solder ball. While irregularity is formed in the upper surface of a plinth, and the touch area of a plinth and a solder ball becomes large and being able to improve both bonding strength by this, the shearing capacity to act on solder at the time of mounting can be eased.

[0012] Moreover, the manufacture method of the semiconductor device concerning this invention The process which prepares and carries out patterning of the 1st resist film the process which forms a conductive metal layer in the active side which has an external terminal, and on the aforementioned metal layer, and leaves the 1st resist film to a part of aforementioned external terminal and corresponding portion, The process which removes the resist film of the above 1st after carrying out half etching of the aforementioned metal layer, The process at which patterning of the 2nd resist film is prepared and carried out to the upper part of the aforementioned activity side, and the aforementioned metal layers other than the portion corresponding to the aforementioned external terminal are exposed, After **********ing and removing the outcrop of the aforementioned metal layer, it was made the composition which has the process which forms the plinth which removes the 2nd resist film and has heights or a crevice in an external terminal position, and the process which covers the aforementioned plinth and prepares a solder ball.

[0013] Furthermore, the manufacture method of the semiconductor device concerning this invention The process which forms a conductive metal thin film in the active side which has an external terminal, and the process at which patterning of the 1st resist film is prepared and carried out on the aforementioned metal thin film, and the aforementioned metal thin film of the portion corresponding to the aforementioned external terminal is exposed, The process which removes the resist film of the above 1st after depositing a conductive metal on the outcrop of the aforementioned metal thin film and forming a metal deposit, While forming and carrying out patterning of the 2nd resist film to the upper part of the aforementioned activity side and carrying out half etching of the process which leaves the resist film of the above 2nd to a part of aforementioned metal deposit, and the outcrop of the aforementioned metal deposit After **********ing and removing the outcrop of the aforementioned metal thin film, it has the composition of having the process which forms the plinth which removes the resist film of the above 2nd and has heights or a crevice in an external terminal position, and the process which covers the aforementioned plinth and prepares a solder ball.

[0014] Furthermore, the manufacture method of the semiconductor device concerning this invention The process at which patterning of the 1st resist film is prepared and carried out to the process which forms a conductive metal thin film in the active side which has an external terminal on the aforementioned metal thin film, and the aforementioned metal thin films other than the portion corresponding to the aforementioned external terminal are exposed, The process which removes the resist film of the above 1st after **********ing and removing the outcrop of the aforementioned metal thin film, The process at which patterning of the 2nd resist film is prepared and carried out to the upper part of the aforementioned activity side, and the aforementioned external terminal and the aforementioned corresponding

metal thin film of a position are exposed, The process which forms the plinth by the aforementioned conductive metal which removed the 2nd resist film and was plated in the external terminal position after plating a conductive metal to the upper part of the resist film of the above 2nd on the exposed aforementioned metal thin film, It is made the composition which has the process which covers the aforementioned plinth and prepares a solder ball. thereby -- a mushroom -- the relief and thing of shearing stress which can form the plinth of a **, and can heighten the bonding strength of a plinth and a solder ball, and act on the solder at the time of mounting are made

[0015]

[Embodiments of the Invention] The gestalt of desirable operation of the semiconductor device concerning this invention and its manufacture method is explained in detail according to an accompanying drawing.

[0016] Drawing 1 is important section explanatory drawing of the semiconductor device concerning the gestalt of operation of this invention, (a) is the cross section, (b) is the plan of a plinth, and (C) and (d) are the plans showing other examples of the irregularity formed in the plinth, respectively.

[0017] In drawing 1 (a), while having formed the plinth 32 to which the semiconductor device 30 used as a semiconductor device turns into an external terminal of an active side from copper, the solder resist 16 is formed in the circumference of a plinth 32, and the gap 20 is formed between the plinth 32 and the solder resist 16. And to the plinth 32, the solder ball 18 is fixed so that the upper surface and the side may be worn. Moreover, two or more heights 34 are formed in the upper surface, and, as for the plinth 32, the touch area (plane-of-union product) with the solder ball 18 is enlarged. Heights 34 and the crevice 36 between heights are formed in band-like as shown in this drawing (b). And in the case of the gestalt of this operation, the diameter of a plinth 32 serves as a size which is about 200-300 micrometers, similarly width of face is formed and, as for heights 34 and the crevice 36, the size of width of face is set to 20-50 micrometers.

[0018] Thus, in the gestalt of the constituted operation, if shearing stress acts on solder (solder ball 18) by the difference of coefficient of thermal expansion with a semiconductor device 30 and a mounting substrate at the time of cooling when mounted in the mounting substrate which fuses a solder ball and does not illustrate a semiconductor device 30 at a reflow furnace etc., heights 34 will bend and deform, will absorb a part of shearing stress, and will ease shearing stress. For this reason, it can prevent that a crack occurs in solder, a plinth 32 separates from the element main part 14, or the element main part 14 is missing. And by having prepared two or more irregularity in the upper surface of a plinth 32, it can become large sharply about the plane-of-union product of a plinth 32 and the solder ball 18, both bonding strength not only can abolish the accident of increase and solder exfoliating, but can distribute the shearing stress which acts on solder, and it can prevent that a crack arises in solder.

[0019] In addition, the heights 34 (or crevice 36) formed in a plinth 32 may be formed in the shape of a checker, as shown in this drawing (c), and as shown in this drawing (d), you may form them in the shape of a concentric circle. And in the gestalt of the aforementioned implementation, although the case where the plinth 32 which has irregularity for the external terminal of a semiconductor device 30 was formed was explained, it is applicable also to the external end-connection child of packages, such as BGA.

[0020] drawing 2 (a) - (d) -- other operation gestalten of a plinth -- being shown . As for the plinth 40 shown in drawing 2 (a), the pillar-like heights 42 are formed in the core on top. In this plinth 40, if shearing stress acts on solder, the heights 42 of a core will bend, a part of shearing stress will be absorbed, and stress will be eased. Furthermore, the center section on top is a crevice 46, and, as for the plinth 44 shown in this drawing (b), the periphery section is heights 48. And if shearing stress acts on solder, the heights 48 of the periphery section deform this plinth 44, and it will absorb shearing stress and will ease.

[0021] the mushroom to which the plinth 50 shown in drawing 2 (c) has an umbrella part 54 in the upper part of a shank 52 and a shank 52 -- it has formed in the ** This plinth 50 eases shearing stress, when the whole bends. In addition, a plinth 50 can be easily formed by plating so that a detail may be mentioned later.

[0022] The plinth 60 shown in drawing 2 (d) forms a crevice 62 deeply, enlarges an aspect ratio and forms it in the shape of [so-called] a needle point holder while it forms a crevice 62 and heights 64 by turns. In the case of the gestalt of operation, a diameter D is 200-300 micrometers, and, as for this plinth 60, 20-100 micrometers and length [of one side] L of heights 64 are formed [height h of the base 66 from the front face of the element main part 14] in 20-50 micrometers for 5-20 micrometers and height (depth of crevice 62) H of heights 64. Since heights 64 bend easily by this by the shearing stress which acts on solder, it is big stress.

[0023] Drawing 3 is explanatory drawing having shown an example of the operation gestalt of the above-mentioned manufacture method of a semiconductor device 30. First, as shown in this drawing (a), a copper layer 70 is deposited on the active side of the element main part 14. After this copper layer 70 forms the thin film of about 1000-7000A copper in the front face of the element main part 14 by sputtering in the case of the gestalt of operation, it is that to which predetermined carried out the thickness deposition of the copper coating on the copper thin film, and has the

thickness of about 50-100 micrometers as a whole.
[0024] Then, photoresists 72 other than the portion which applies and carries out patterning of the photoresist 72 which is the 1st resist film to the front face of a copper layer 70, and forms the plinth corresponding to the external terminal of an element in it are removed, and a copper layer 70 is exposed (this drawing (b)). Next, after forming the plinth 32 which **********s the exposed copper layer 70 and consists of copper (this drawing (c)), the photoresist 72 which remained on the plinth 32 is removed (this drawing (d)). Furthermore, as shown in drawing 3 (e), patterning of the photoresist 74 which is the 2nd resist film is applied and carried out to the upper part of the element main part 14, and it leaves a photoresist 74 only to the portion which forms the heights on a plinth 32. Then, half etching of the plinth 32 is carried out, and it is made the plinth 32 which removes a photoresist 74 and by which the crevice 36 was formed in the predetermined depth, and heights 34 and the crevice 36 were formed in the upper surface (this drawing (f)). Next, as shown in this drawing (g), a plinth 32 is covered, the solder ball 18 is formed, and it considers as a semiconductor device 30.
[0025] In addition, barrier metal, such as chromium (Cr), a (Titanium Ti) titanium-tungsten alloy (TiW), or nickel (nickel), can be prepared between a plinth 32's and the element main part 14 if needed.
[0026] Drawing 4 shows other operation gestalten of the manufacture method. After predetermined carries out the thickness deposition of the copper layer 70 like [the front face of the element main part 14] the above first (drawing 4 (a)), this manufacture method applies and carries out patterning of the photoresist 72 which is the 1st resist film to the front face of a copper layer 70, and leaves only the photoresist 72 of the portion corresponding to the heights of a plinth (this drawing (b)). Then, after carrying out half etching of the portion which has exposed the copper layer 70, heights 34 and a crevice 36 are formed in the position in which the photoresist 72 which remains is removed and a plinth is prepared (this drawing (c)). Next, as shown in this drawing (d), photoresists 74 other than the portion which applies and carries out patterning of the photoresist 74 used as the 2nd resist film to the front face of a copper layer 70, and forms a plinth in it are removed, and a copper layer 70 is exposed. Next, after **********ing and removing the exposed copper layer 70, the plinth 32 which removes the photoresist 74 of the plinth formation section and has irregularity is formed (this drawing (e)). Then, as shown in this drawing (f), a plinth 32 is covered and the solder ball 18 is formed.
[0027] Drawing 5 shows the manufacture method of the semiconductor device further applied to the gestalt of other operations. This manufacture method forms the copper thin film 76 in the front face of the element main part 14 by sputtering first, as shown in drawing 5 (a). The thickness of this copper thin film 76 may be 1000-7000A. Then, patterning of the photoresist 72 is applied and carried out on the copper thin film 76, and the photoresist 72 of the position which forms a plinth is removed (this drawing (b)). Furthermore, a photoresist 72 is removed, after plating copper into the portion which removed the photoresist 72 and forming a deposit 78, as shown in this drawing (c) (this drawing (d)).
[0028] Next, as shown in drawing 5 (e), patterning of the photoresist 74 is applied and carried out to the upper part of the element main part 14, and it leaves a photoresist 74 only to the portion corresponding to the heights formed in the copper-coating layer 78. And while **********ing and removing the exposed copper thin film 76, after carrying out half etching of the copper-coating layer 78, the photoresist 74 on the copper-coating layer 78 is removed, and the plinth 32 which has heights 34 and a crevice 36 is formed in the upper surface (this drawing (f)). Then, a plinth 32 is covered like the above, the solder ball 18 is formed, and a semiconductor device 30 is completed.
[0029] drawing 6 -- a mushroom -- the operation form of the manufacture method of a semiconductor device of having the plinth of a ** is shown First, as shown in drawing 6 (a), the copper thin film 76 is formed in the front face of the element main part 14 by sputtering. Next, patterning of the photoresist 72 used as the 1st resist film is applied and carried out on the copper thin film 76, and copper thin films 76 other than the external terminal of the element main part 14 and the corresponding portion are exposed (this drawing (b)). Then, as shown in this drawing (c), after **********ing and removing the outcrop of the copper thin film 76, the photoresist film 72 which it left to the correspondence position with an external terminal is removed. Furthermore, patterning of the photoresist 74 used as the 2nd resist film is applied and carried out to the upper part of the element main part 14, the photoresist 74 of the copper thin film 76 upper part is removed, and the copper thin film 76 is exposed (this drawing (d)).
[0030] Next, on the exposed copper thin film 76, copper is plated and the copper-coating layer 80 is formed (drawing 6 (e)). This copper-coating layer 80 is performed until it rises in the upper part of a photoresist 74 as shown in drawing. thereby -- the copper-coating layer 80 -- the circumference of the hole 82 of the upper surface of a photoresist 74 -- spreading -- a mushroom -- it becomes a ** and the copper deposit 80 -- a mushroom -- the photoresist 74 if formed in a **, after washing and drying -- removing -- a mushroom -- the plinth 50 of a ** is formed Then, a plinth 50 is covered and the solder ball 18 is formed.
[0031]

[Effect of the Invention] By having established heights or the crevice in the plinth which fixes a solder ball according to this invention, as explained above When a solder ball is fused and a semiconductor device is mounted in a substrate, by the shearing stress which acts on the solder (solder ball) by the difference of coefficient of thermal expansion with a semiconductor device and a mounting substrate Heights, Or since the height of the circumference which forms the crevice deforms and a part of shearing stress is absorbed, shearing stress is eased and it can prevent a crack arising in solder, or a plinth separating, or producing a chip in a semiconductor device. Moreover, while it becomes large about the plane-of-union product (touch area) of a plinth and a solder ball and both bonding strength becomes large by having formed heights or the crevice in the plinth, the shearing stress which acts on solder can be distributed and it can prevent that a crack etc. arises in solder.

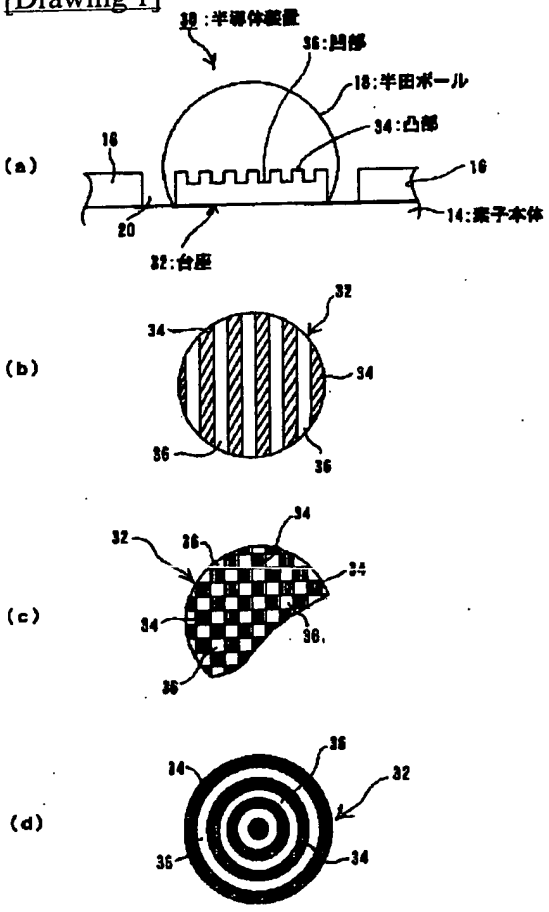
[Translation done.]

* NOTICES *

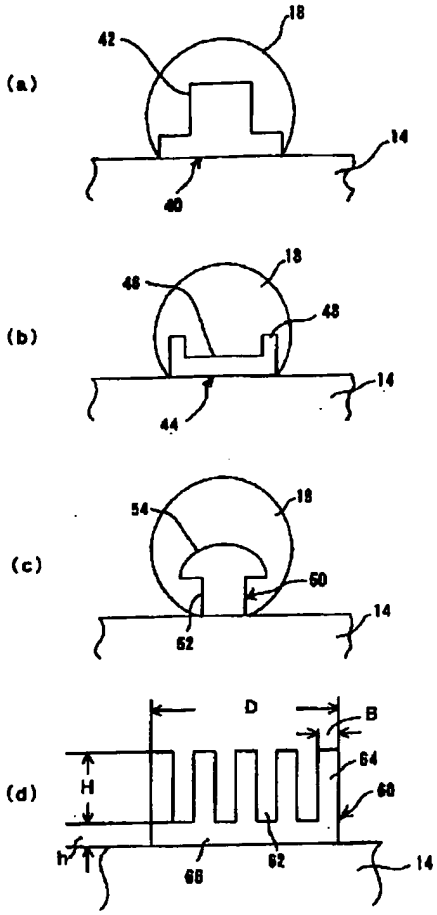
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

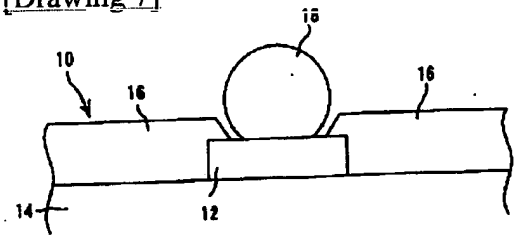
[Drawing 1]



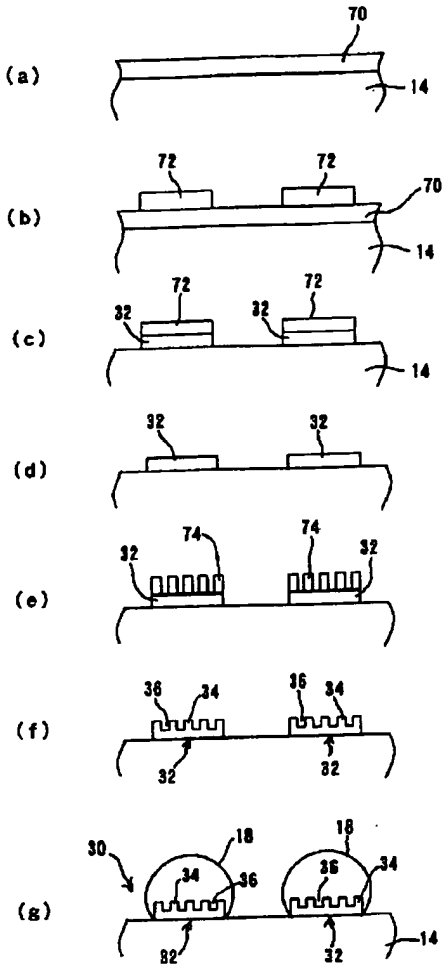
[Drawing 2]



[Drawing 7]



[Drawing 3]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(c)
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(d)
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(e)
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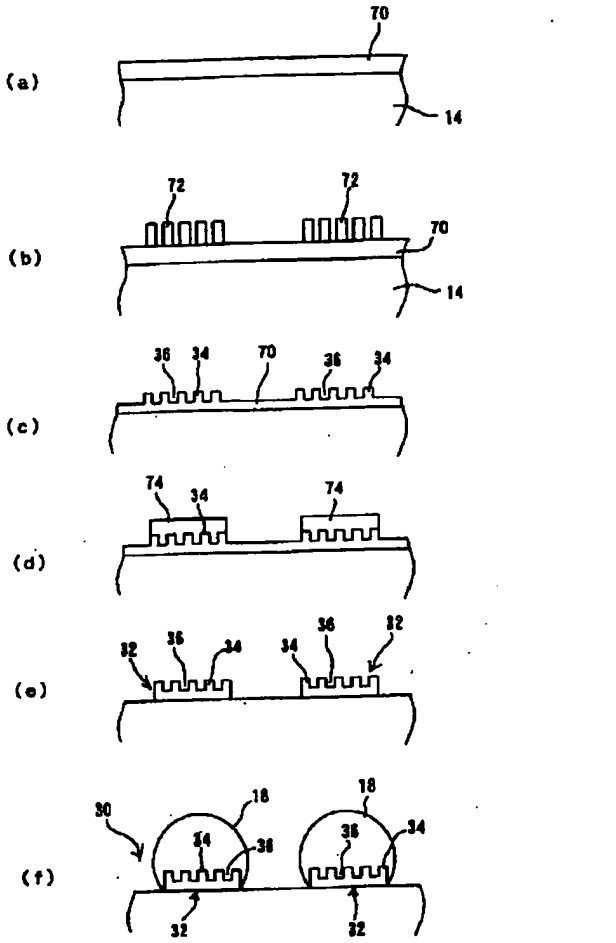
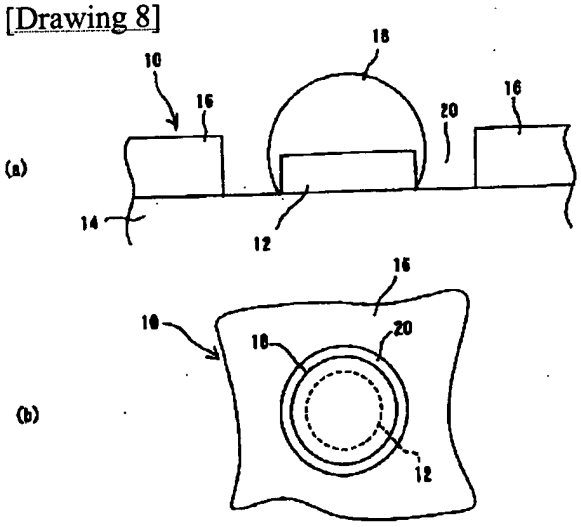
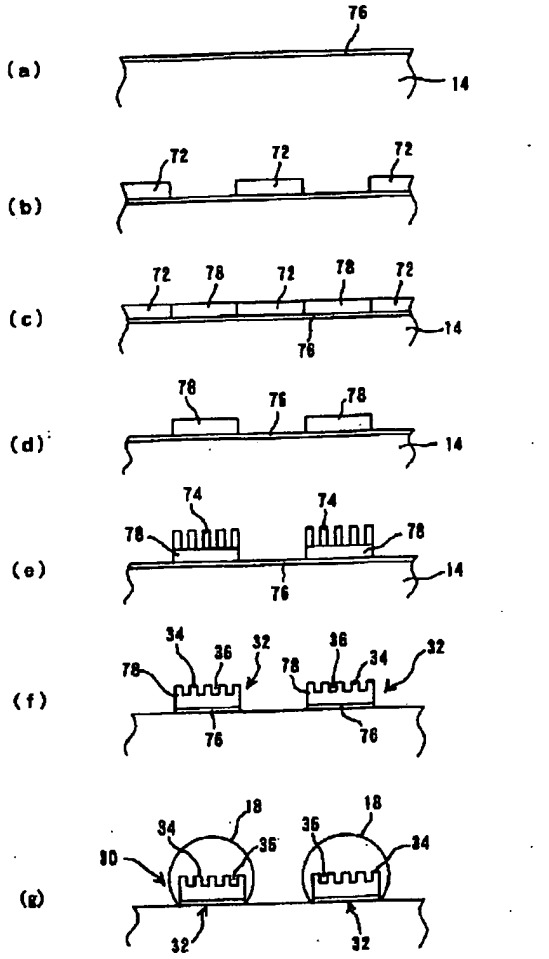
[Drawing 4]



[Drawing 8]



[Drawing 5]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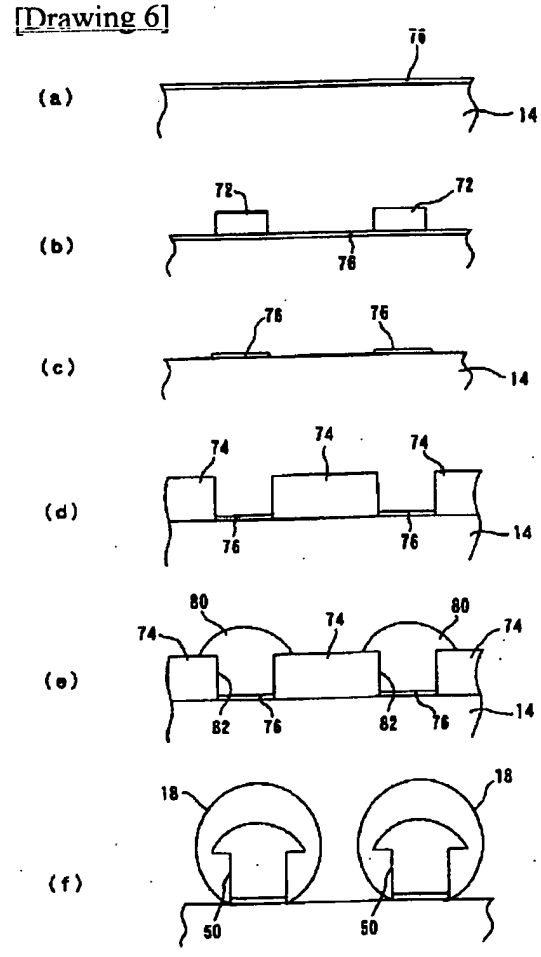
[Drawing 6]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